BINDURA UNIVERSITY OF SCIENCE EDUCATION

DEPARTMENT OF CROP SCIENCE

EVALUATION OF PLANTING TIME AND POPULATION DENSITY ON SESAME CROP DEVELOPMENT.

KURUSO RUMBIDZAI

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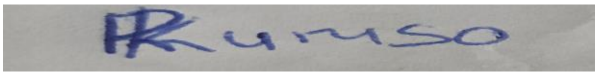
SUPERVISOR: MS KAMOTA

DECLARATION.

BINDURA UNIVERSITY OF SCIENCE EDUCATION FACULTY OF AGRICULTURE AND ENVIRONMENTAL SCIENCE

The undersigned certify that they have read and recommend to the Department of Crop Science, this thesis entitled:

Student:

Signature 

Date : 17/09/2025

Supervisor:

Ms. Kamota

Signature Date

Chairperson:

Mr. Mutsengi

Signature Date

ABSTRACT

This research explored how different planting times and plant population densities affect how sesame grows and how much it produces, focusing on small scale farmers in Zimbabwe. The field trials were held at Chipinge Coffee Research Station using 3 x 3 factorial treatment structure, laid in a randomized block design with three planting dates (2 January 2025, 22 Jan 2025 and 5 Feb 2025) and three plant densities (333 333; 250 000 and 222 222 plants per hectare). The experiment was replicated three times. The researcher looked at factors like plant height, number of branches, time to flowering, and grain yield. The results showed that planting earlier and using medium density (222 222plants/ha) led to better overall growth and productivity. This setup helped plants take full advantage of moisture and temperature conditions, supporting better development. Based on these findings, early planting and moderate spacing (30cm x 15cm) are recommended for smallholders aiming to get better sesame yields. The study also highlights the need for more research across different regions to fully understand the reasons behind these results.

ACKNOWLEGMENTS

First and foremost, I give the most to Him the Lord God Almighty for having blessed me with such an opportunity to education and life above all. I would like to extend my sincere gratitude to the following for their valuable contributions to this project, Program chairperson Mr. K Mutsengi and Ms. A Kamota for their guidance and expertise throughout this journey. Mwatsiya N., Sandazani H. and Chikasha E. for your collaboration and support. Mr. and Mrs. Kuruso for the financial support that made this project possible.

DEDICATION

I dedicate this project to my parents and family at large.

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CHAPTER 1: INTRODUCTION

1:1 BACKGROUND OF STUDY

Sesame (*Sesanum indicum* L.) is a key oilseed crop known for its rich nutritional profile, high-quality oil, and capacity to thrive across a range of agro-ecological zones (Pathak et al., 2014). Although sesame's broad cultivation in India led many researchers to consider it the crop's centre of origin, evidence suggests that its true roots lie in Africa, where a greater genetic diversity of both cultivated and wild relatives is found (Madhanzi & Manjeru P, 2004). By 1993, global sesame seed trade had reached 486 000 metric tons, with Japan emerging as the largest importer, accounting for 24% of total world imports (Bennet et al., 1995).

Environmental factors play a crucial role in determining the success of different planting date and population density combinations. Temperature requirements for optimal germination and early establishment (20-30°C) must be met through appropriate timing of planting (Langham, D. R., 2007). Similarly, rainfall distribution patterns influence soil moisture availability during critical growth stages, affecting plant development and yield formation processes.

In Zimbabwe, the country's lowveld regions, with their hot, dry weather, are where sesame is primarily grown. The three regions in Zimbabwe that produce the most sesame is Masvingo, Manicaland and Mashonaland Central (Pophiwa, J.M, 2023). Sesame is usually planted using a hand hoe or a planter. The seeds are planted at a depth of 1-2 cm and spaced at a distance of 20-30 cm between rows. The seed rate used is usually 5-8 kg per hectare (Systems, Sesame Production, 2014).

As global demand for sesame products continues to rise, optimizing cultivation practises, particularly planting dates and population density, has become crucial for maximizing yield potential and crop development. The timing of planting significantly influences sesame crop performance through its interaction with environmental factors such as temperature, rainfall patterns and day length. Research has demonstrated that appropriate planting dates ensure optimal growing conditions during critical phenological stages, ultimately affecting yield components and seed quality (Olowe, V.

I. O., & Busari, L. D., 2017). Early planting typically allows crops to utilize the full growing season and escape end-season stresses, while late planting may expose plants to unfavourable conditions during crucial developmental phases.

Population density management represents another critical aspect of sesame cultivation that directly impacts resource utilization, plant architecture, and yield formation. Optimal plant spacing ensures efficient light interception, reduces intraspecific competition, and promotes better air circulation within the crop canopy (Ahmed, S., Islam, M. N., & Hossain, M. M., 2020). Studies have shown that plant population density influences stem height, branching patterns, capsule formation, and ultimately, seed yield per unit area.

The interaction between planting dates and population density creates a complex relationship that affects crop growth dynamics and yield components. Research has indicated that different planting dates may require adjusted population densities to optimize resource use efficiency and maximize yield potential (Kumar, M., & Goel, M., 2019). This relationship varies across geographical locations, cultivars, and environmental conditions, necessitating region-specific recommendations for sustainable sesame production.

Recent advances in agronomic research have highlighted the need for integrated approaches to sesame cultivation, considering the interdependence of various management practices. Studies have demonstrated that optimal combinations of planting dates and population density can significantly improve water use efficiency, nutrient uptake, and overall crop performance (Rahman, M. M., Haque, M. E., & Alam, M. S., 2016). Furthermore, these practises influence pest and disease pressure, weed competition, and harvest efficiency.

Modern agricultural challenges, including climate change and variable weather patterns, have heightened the importance of understanding these cultivation parameters. Farmers must adapt their management practices to maintain stable yields under increasingly unpredictable growing conditions. The optimization of planting dates and population density serves as a low-cost strategy to enhance crop resilience and productivity (Ali, A., & Jan, A., 2021).

This knowledge enables farmers to make informed decisions about cultivation practices while considering local environmental conditions and market demands. Continued research in this area remains crucial for addressing emerging challenges in sesame production and ensuring food security in regions where sesame serves as a significant oilseed crop.

1:2 PROBLEM STATEMENT

The absence of region-specific guidelines exacerbates yield variability, resulting in economic losses and threatening food security. Therefore, a comprehensive understanding of the relationship between planting dates and population density is imperative for developing sustainable agricultural practices that enhance sesame productivity and contribute to agricultural resilience in the face of climate change.

1:3 JUSTIFICATION

Sesame *(Sesanum indicum*) is a critical crop for oil production and food security, yet its yields and quality are often limited by inadequate farming practices (Kuol, 2004). The use of different planning dates and population densities can significantly impact sesame production but the current lack of data on this topic hinders informed decision-making by small-scale farmers and researchers (Nations, 2018) .The results are going to provide an addition to which small-scale farmers and the agricultural sector as a whole can explore on time of planting and population density in the production of sesame.

1:4 OBJECTIVES

1:4:1 MAIN OBJECTIVE

To assess the impact or effects of population density and planting time on Sesame Performance.

1:4:2 SPECIFIC OBJECTIVES

1. To assess the effect of planting time and population density on vegetative growth of sesame.

2. To determine the effect of planting time and population density on reproductive growth.

3. To evaluate the impact of planting times and population density on days to flowering and yield.

1:5 HYPOTHESES

H_1: Alternative hypothesis

1. There is a significant difference in the effects of planting dates and population density on vegetative growth.
2. There is a significant difference in the effects of planting dates and population density on reproductive growth.
3. There is a significant difference in the effects of planting dates and population density on days to flowering and yield.

CHAPTER 2: LITERATURE REVIEW

2.0 TAXONOMY AND ORIGIN OF SESAME

Sesame (Sesamum indicum) is a plant in the genus Sesamum, cultivated for its edible seeds that grow in pods. The sesame and the wild species closely related to it are classified in the family Pedaliaceae (Sesame family) and genus Sesamum. It is a popular oilseed crop with high medicinal value and is widely grown in tropical and subtropical regions (Madhanzi & Manjeru P, 2004). The plant is a perennial. Sesame is believed to be one of the oldest oilseed crops known to humanity, with archaeological evidence suggesting domestication in the Indian subcontinent over 5,500 years ago (Bedigian, D., 2010).

According to (Shurtleff, W., & Aoyagi, A., 2022) with charred traces of sesame dating to approximately 3500- 3050 Before Common Era (BCE), archeological evidence points to the Indian subcontinent as the place where sesame was domesticated at least 5500 years ago. The cultivated type of sesame, S. indicum, is thought to have its roots in India. Sesame trade is said to have started approximately 2000 BC between Mesopotamia and the Indian subcontinent, suggesting earliest ties between these areas. Sesame trade is said to have started approximately 2000 BC between Mesopotamia and the Indian subcontinent, suggesting earliest ties between these areas (Anderson, 2023).

2:1 BIOLOGICAL DESCRIPTION

According to (Siddique, K. H. M., & Li, X., 2018), sesame is predominantly an upright annual herb, although some perennial types do exist. Its height typically ranges from 0.5 to 2.5 meters, depending on the specific variety and environmental conditions. (Halle, F., & Oldeman, R. A. A., 2012) explains that the main stem is usually cylindrical, although certain varieties may exhibit branching. These can be classified as either single-stemmed with minimal or indistinct lateral growth or multi stemmed types, which are more conspicuously branched and generally bushier in appearance.

The leaves are arranged oppositely along the stem, simple in structure, and possess smooth, entire margins. As one moves up the plant, the leaves tend to become narrower and more lanceolate in shape, whereas the lower leaves are broader and more rounded.

Sesame develops a deep taproot system with extensive lateral roots, supporting its growth.

(Abrol, 2024) notes that the plant's flowers usually appear singly or in pairs or trios within the axils (the junction where leaves meet the stem). Although sesame is primarily self-pollinating, cross pollination can occur, facilitated by insects such as bees and bumblebees.

2:2 GLOBAL DISTRIBUTION

Sesame is cultivated extensively across the globe, with production concentrated in several key nations. In 2018, Sudan, Myanmar and India emerged as the top producers, collectively accounting for a significant proportion of global sesame seed output (Nations, F. and A. , 2019).

The (Yearbook, Statistical, 2023) highlights Africa as the leading region in global sesame production, contributing approximately 70% of the total output. Within the continent, Ethiopia led with an estimated 1.3 million metric tons, followed by Sudan with 600 000 metric tons. Other notable African producers include Tanzania, Nigeria and Uganda, although their exact annual contributions tend to vary. Asia also plays a substantial role, contributing around 20% to global production. Among Asian countries, India and Myanmar were major producers, with outputs of 650 000 and 500 000 metric tons respectively. China and Japan also contribute to regional production, albeit at smaller scales. In the Americas, sesame cultivation is gaining momentum, now counting for roughly 10% of global output. Guatemala and Nicaragua are leading this growth, with Mexico and the United States also showing increasing involvement and potential for expansion.

According to (Majuru, A., 2024), Zimbabwe set an ambitious target of producing 100 000 tonnes of sesame during the 2020/21 summer growing season. While its precise share in Africa's total output remains unclear, Zimbabwe's contribution to the global sesame seed export market was valued at $85 000 in 2019, a modest figure when compared to the global export value of $3 billion that year. The domestic sesame sector is supported by over 1200 small holder farmers, and trial yields in Zimbabwe have averaged between 1000 and 1500kg/ha, with irrigated plots demonstrating the potential to achieve up to 1050kg per acre.

2:3 IMPORTANCE OF SESAME

Sesame seeds serve diverse roles in both culinary and industrial contexts, with their most prominent use being the extraction of sesame oil, a product highly sought after in global cuisine and food manufacturing (Bedigian, D., 2010). Nutritionally, sesame seeds are rich in healthy fats, proteins, dietary fiber, and essential micronutrients, including B vitamins, vitamin E, calcium and iron. This robust nutrient composition contributes meaningfully to heart and bone health, as well as digestive well- being. Consumption of sesame spans from simple garnishing on baked goods and salads to being the core ingredient in traditional preparations such as gomasio.

Recent technological innovations, particularly the adoption of mechanized harvesting and the cultivation of non-shattering varieties have significantly boosted sesame productivity. These advancements, as noted by (Nations, F. and A., 2022), not only reduce labor inputs but also enhance yield, thereby improving the economic viability of sesame cultivation. For many smallholder farmers, sesame farming has become a viable avenue for income generation and improved livelihoods. The crop's adaptability and resilience to drought make it particularly well-suited to resource constrained farming systems.

Moreover, integrating sesame into crop rotation schedules has been identified as a strategic approach to mitigate risks tied to market volatility and climatic challenges, ultimately enhancing farm level profitability (Commerce, U. S, 2015). Beyond its culinary appeal characterized by a high smoke point and distinctive, stable flavor sesame oil also finds application in sectors such as cosmetics, pharmaceuticals and industrial lubrication reinforcing its versatility and economic value.

2.4 NUTRITIONAL VALUE OF SESAME

As noted by (Stanfield, D., 2009), sesame is recognized as one of the most widely cultivated and nutritionally valuable oilseeds in certain regions, owing to its high content of macronutrients such as proteins, healthy fats and dietary fiber. It is also a rich source of essential micronutrients, including the vitamin B complex and key minerals like magnesium, calcium, phosphorous and copper. In addition to its nutritional composition, (Gupta, A. M., & Anjali, M., 2024) highlights sesame's anti-inflammatory properties, which contribute to the neutralization of free radicals and the reduction of inflammation within the body. These beneficial compounds are primarily located in the seed's core commonly referred to as the "bead". The overall quality of sesame seeds, however, is influenced by multiple factors, including agronomic practices, climatic conditions, post-harvest processing methods and genetic variability.

Table 1: *The nutrional value of sesame seeds (per 1/4cup or 30gram serving).*

Nutrient	**Amount**	**Daily Value (DV) %**
Calories	163	8
Total fat	18	28
Saturated fat	2.6	13
Monosaturated fat	9.7	
Polysaturated fat	5.3	
Protein	6	12
Carbohydrates	8	3
Fiber	4	16
Sugar	1.5	3
Vitamins		
VitaminB1 (Thiamine)	0.3	20
Vitamin B3 (Niacin)	1.1	7
Vitamin B6 (Pyridoxine	0.1	5
Folate	18mcg	5
Vitamin E(Tocopherol)	0.9	6
Minerals		
Copper	1.3	65
Manganese	1.7	83
Calcium	291	29
Magnesium	116	29
Iron	2.7	15
Phosphorous	669	95
Selenium	1.7	34

Source: (Blaak, 2023)

2.5 CONSTRAINTS TO SESAME PRODUCTION

Determining optimal planting dates and managing plant population density remain critical yet complex aspects of sesame cultivation, with direct implications for crop performance and yield outcomes. As established by (Mekuriaw, T., et al, 2020) and (Ghosh et al., 2021), planting time plays a pivotal role by mediating the crop's exposure to key environmental variables such as temperature patterns, rainfall distribution and pest pressures.

Sesame is particularly sensitive to the timing of sowing, given its dependence on precise climatic conditions for successful development. Deviations from the ideal planting window, either premature or delayed can adversely impact yields due to unfavorable weather alignment. For instance, exposure to drought stress during critical growth phases, as highlighted by (Hussain et al., 2023), can significantly limit productivity. Furthermore, suboptimal timing may intensify weed interference and escalate susceptibility to pest and disease outbreaks, compounding production losses.

Population density also exerts a profound effect on sesame growth dynamics. Sparse planting such as densities around 66 667 plants per hectare, may reduce inter-plant competition but often results in shorter plants with diminished branching and fewer capsules per plant. Conversely, higher planting densities enhance total seed yield per hectare by maximizing land use efficiency, though this often comes at the expense of individual plant traits such as capsule number and seed weight. These trade offs underscore the importance of localized, agronomically tailored strategies to optimize sesame production in diverse ecological contexts.

2:6 EFFECTS OF PLANTING TIME AND POPULATION DENSITY ON VEGETATIVE, REPRODUCTIVE AND YIELD STAGES.

Planting time and population density significantly influence the vegetative stage of sesame *(Sesanum indicum)* production. Time of planting affects environmental conditions like temperature, day-length and soil moisture, which directly impact the vegetative growth stage. For instance, early sowing under optimal conditions can extend the vegetative stage, promoting robust leaf development and lateral branching essential for photosynthesis and seed production. Whilst late planting may shorten the vegetative phase due to accelerated transitions to flowering caused by reduced day-length or temperature fluctuations. High population density (10-20cm apart) increases competition for sunlight, nutrients and water, potentially reducing individual plant growth during the vegetative stage (El Naim, A. M., et al., 2010). Dense planting can lead to taller but thinner plants with fewer lateral branches as they compete for light. This compromises the overall photosynthetic capacity during the vegetative stage. Whilst optimal spacing ensures balanced growth, allowing plants to develop broad leaves and strong lateral branches critical for seed production later in the lifecycle.

Planting time plays a crucial role in determining the growth duration, flowering initiation and pod development in sesame. Sesame planted at the recommended time (e.g spring or early summer depending on region) experiences favorable temperature and photoperiod, leading to synchronized flowering and higher pod setting (Anitha, R., et al, 2017). Delay in planting exposes the crop to unfavorable conditions such as high temperature, drought, or early frost, leading to flower abortion, reduced pod formation and lower seed yield (Adebisi et al., 2013). Population density affects the availability of light, nutrients and moisture, which in turn influences the reproductive development of sesame. Lower population density, that is 30-40cm apart, encourages better light penetration and air circulation, leading to increased branching, more flowers and higher pod set per plant (Teshome, A., et al., 2018). However, it may reduce total yield per hectare due to fewer plants. High population density (10-20cm apart) leads to increased competition for resources, which can result in fewer flowers per plant and lower pod formation (Ali, E. A., Mohammed, A. A., & Mohammed, E. A., 2012). Overcrowding, can also delay flowering leading to uneven maturity and reduce seed size and oil content.

Planting time and population density are critical factors that greatly affect the yield of sesame in Zimbabwe. Sesame thrives well in warm climates and semi-arid conditions, making it suitable for areas in Zimbabwe such as Masvingo, Muzarabani and Chiredzi (Pophiwa, J.M, 2023). Planting should align with the onset of rains to ensure adequate soil moisture during germination and early growth stages. Late planting can expose the crop to water stress during flowering and seed formation, reducing yields. Population density impacts light interception, nutrient competition and overall plant health. Proper spacing ensures adequate sunlight penetration and reduces competition for nutrients and water. Overcrowding can lead to stunted growth and poor yields. Research suggests that moderate population densities optimize yields by balancing plant competition and resource use efficiency (Ahmed, S., Islam, M. N., & Hossain, M. M., 2020). High densities may increase susceptibility due to poor air circulation.

CHAPTER 3: MATERIALS AND METHODS

3.0: METHODOLOGY

3.1 STUDY AREA

The study was carried out at the Chipinge Coffee Research Station, situated approximately 10 kilometres east of Chipinge town in Zimbabwe's Manicaland Province. Positioned at an elevation of 987.1 meters above sea level, the station lies at coordinates 32.6503^{o}E longitude and 20.2353^{o}S latitude. The site features well-drained clay-loam soils with a Ph range between 5.0 and 8.0 (Agritex, 2010), offering a suitable medium for a variety of agricultural trials.

The location falls within Zimbabwe's agroecological region I, which is known for receiving relatively high annual rainfall ranging between 850 and 1000 millimetres. The area experiences a mean annual temperature of approximately 25^{o}C. Notably, frost is common during the cooler months, particularly from June through early August. Despite generally favourable conditions, the region is occasionally affected by mild and sporadic droughts. The broader farming landscape in this region is characterized by extensive agricultural systems, reflecting both the environmental potential and constraints of the area.

3.2 EXPERIMENTAL DESIGN

A 3x3 factorial treatment structure laid in a Randomized Complete Block Design (RCBD) was used. The first factor was planting date which had 3 levels (2 January, 22 January and 5 February) and the second factor was plant population which had three levels (30cm x 1ocm (333333 plants/ha), 30cm x15cm (222 222 plants/ha), 40cm x 10 (250 000 plants/ha). The trial was replicated three times. The blocking factor was soil type. The trial was replicated three times.

3.3 GENERAL MANAGEMENT

3.3.1 Land Preparation:

The land preparation for the experiment was through conservation method. An ox-drawn mouldboard plough was used to mark the planting lines. The experimental plots were marked, measuring 3m x 3m and separated by 0.5m walking pathways. In addition, the blocks were separated by 0.5m paths to ensure correct demarcation. A depth of 20 to 25cm was used which physically supported the plant and allowed the use of sufficient moisture and nutrients. A total land of 58.5m^2 was used to carry out the experiment.

3.3.2 Water Management:

The sesame was on an open field and dependant on rain-fed moisture. The crop experienced relatively high moisture due to excessive rains which came late as the season was progressing. Drains were constructed within the field in order to allow excess water to flow to reduce the crop lodging.

3.3.3. Weed Management:

Plots were kept weed-free during the testing period. Weeding was done with a hoe, followed by hand pulling, to ensure good weed control. No herbicides were applied for the control of weeds.

3.3.4 Fertilizer Application:

75kg/ha of nitrogen is recommended. Compound C was be used for basal dressing because it contains boron which helps during flowering, applied at the rate of 150kg/ha. Top dressing was applied twice during the fourth week and soon after flowering commenced. Ammonium nitrate was used as top dressing at a rate of 200kg/ha. The split application method was used for the application of AN with 75% of the 200kg/ha applied during the first application and the remaining 25% was applied during the last application.

3.3.5 Pest and Disease Management:

Chemical and cultural approaches were used for pest and disease control. Disease-free seed was used, and thinning was done at vegetative stage, this was done to remove weak or diseased seedlings at 10 to 15cm plant height. Snails and tortrix moths were encountered during the experiment. The snails were mainly due to excessive moisture in the soil. Thunder was used for the control of these pests.

3.4 DATA COLLECTION

To examine the sesame plant's development and performance, the following parameters were measured and recorded:

3:4:1 Plant Height

The height in centimetres of random plants in each block was measured and the average per treatment for the growing season was used. The height from the plant's base to the tip of the longest leaf was measured and recorded using a tape measure.

3:4:2 Pod number

The number of pods per random plant was counted after top-dressing to assess pod-development.

3:4:3 Branch number

The number of branches per random plants was counted after top-dressing to assess branching habit. Only primary branches extending from the main stem were counted.

3:4:4 Days to flowering

The time to flowering was recorded as the number of days from planting to the observation of at least 50% of plants in treatments with at least one fully bloomed flower.

3:4:5 Total grain yield

It was determined by harvesting plant material at maturity, the total grain yield was determined by threshing mature sesame capsules to separate the seeds and dry them until constant moisture was reached. The total yield was determined by multiplying the number of pods by a constant figure for all the treatments. Total grain yield was recorded in grams per treatment or per unit area (kg/ha).

3.5 DATA ANALYSIS

Prior to statistical analysis, the dataset was examined to ensure it met the assumptions of normal distribution and homogeneity of variances. Once these conditions were satisfied, analysis of variance (ANOVA) was performed using GenStat, 18^{th} edition. Differences among treatment means were then assessed using the Least Significant Difference (LSD) method at a significance level of $P<0.05$.

CHAPTER 4: RESULTS

4:1 EFFECTS OF PLANTING DATES AND POPULATION ON SESAME DAYS TO FLOWERING

There were interactions effects at ($P<0.05$) between planting date and population density.

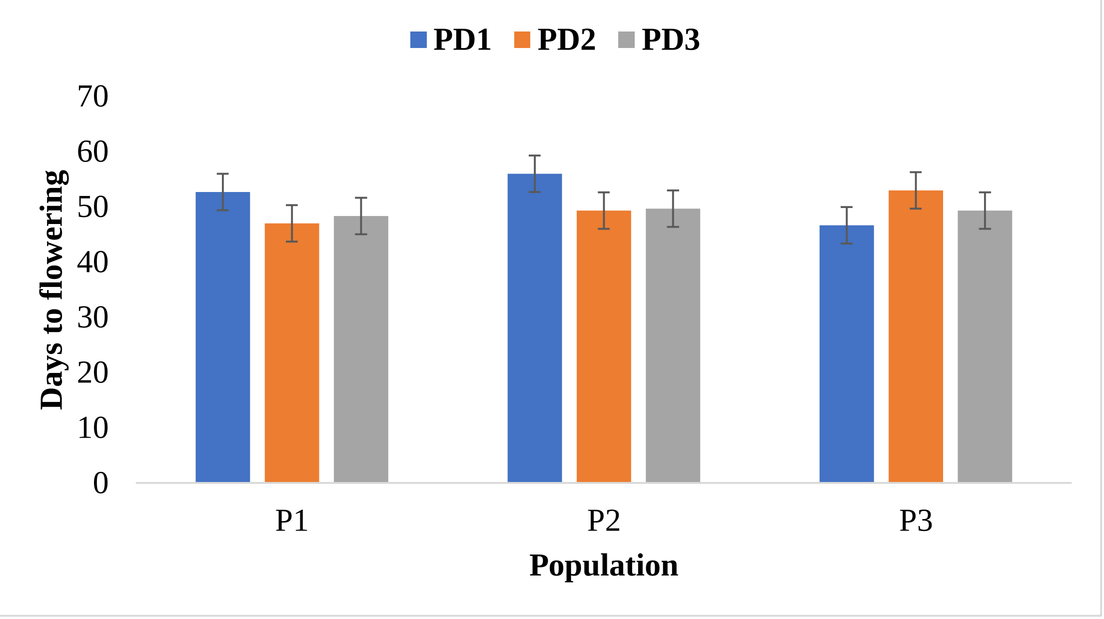

Figure 1: *Effects of planting date and population on sesame days to flowering*

There was a significant difference at ($P<0.05$) on sesame with PD1 and population 2(P2). The highest number of days to flowering was observed in plants grown under planting date 1 (PD1) and population 2 (P2).

4:2 EFFECTS OF PLANTING TIME AND POPULATION ON SESAME NUMBER OF PODS

There was no significant interaction effect at ($P<0.05$) between planting date and population. There was no significant difference at ($P<0.05$) on sesame. The highest pod number was achieved in plants under population 2 and planting date 1(36.7a) whilst the lowest was recorded on population 1 and planting date 3 (4.0a mean).

	Population		
Planting Date	P1	P2	P3
PD1	29.7a	36.7a	26.0a
PD2	17.0a	24.7a	28.3a
PD3	4.0a	24.3a	23.7a
Grand Mean	23.8	23.8	23.8
CV (%)	36.5	36.5	36.5
LSD (5%)	18.22	18.22	18.22

Table 2: *Effects of planting time and population on pod development*

4:3 EFFECTS OF PLANTING DATE AND POPULATION ON SESAME HEIGHT

There was significant interaction effect at (P<0.05) between planting date and population. There was a significant difference at (P<0.05) on sesame with planting date 1 and population. A higher plant height was observed in plants grown under planting date 1 and population 2.

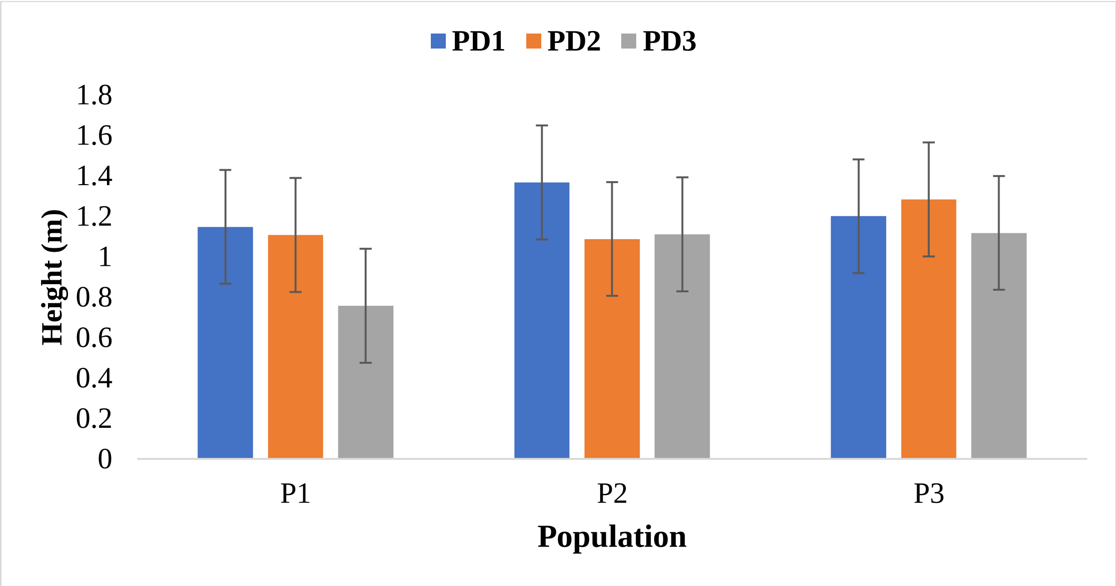

Figure 2: *Plant response to different planting dates and population*

4:4 EFFECTS OF PLANTING DATE AND POPULATION ON THE BRANCHING HABIT OF SESAME PLANTS

There was significant interaction effect at ($P<0.05$) between planting date and population. There was a significant difference at ($P<0.05$) on sesame with PD 1 and P2. A higher number of branches was observed on plants grown under PD1 and P2.

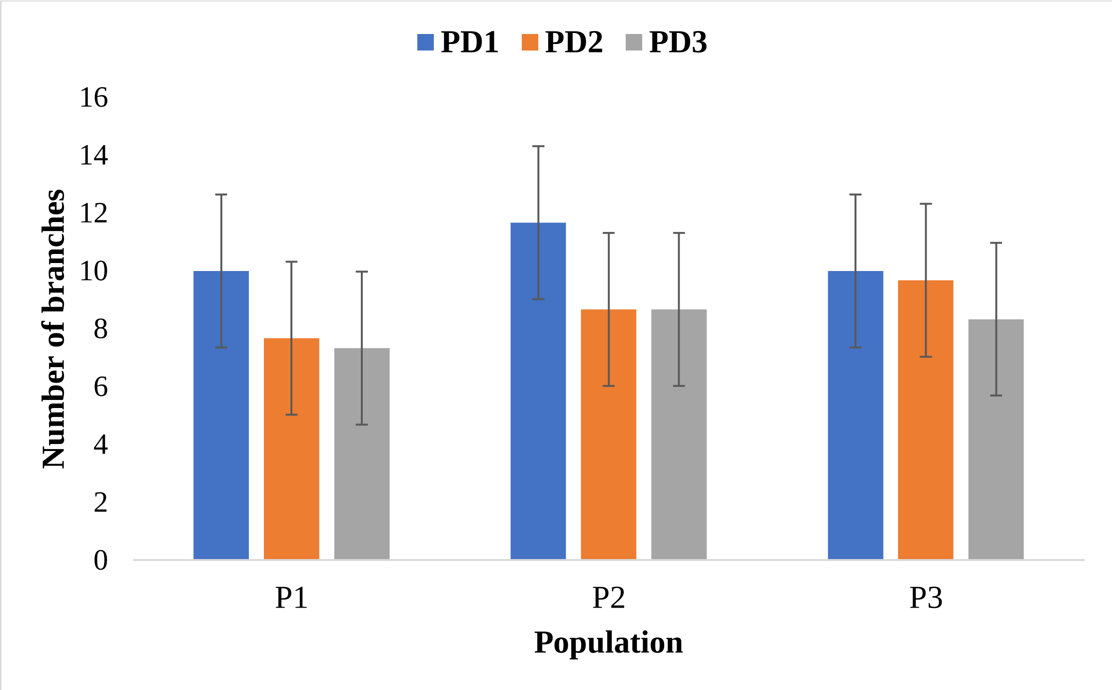

Figure 3: Plant response of different planting dates and populations

4:5 EFFECTS OF PLANTING DATE AND POPULATION ON SESAME POD LENGTH

There was significant interaction effect at ($P<0.05$) between planting date and population. There was a significant difference at ($P<0.05$) on sesame with PD1 and P3. The highest recorded length was between PD1 and P3.

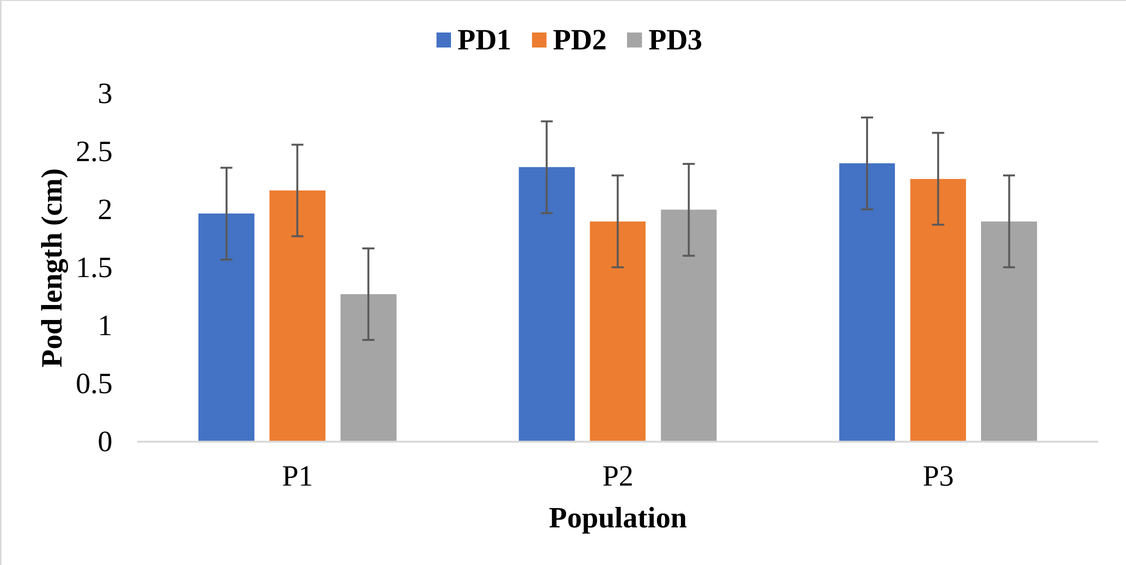

Figure 4: *Plant response to different planting dates and population*

4:6 EFFECTS OF PLANTING TIME AND POPULATION ON YIELD (kg/ha) OF SESAME.

There was significant interactions effect at (P<0.05) between planting date and population. There was a significant difference at (P<0.05) on sesame planting time and population density. The highest yield was recorded under planting (PD1) and population (P2), (12.319kg/ha) and the lowest was at planting (PD3) and population (P1), (1.052kg/ha).

Planting Date	**P1**	**P2**	**P3**
PD1	9.546ab	12.319a	9.108ab
PD2	3.951bc	3.263c	9.939a
PD3	1.052c	5.869bc	5.179bc
Grand mean (co)	6.69	6.69	6.69
CV (%)	10.32	10.32	10.32
LSD (5%)	5.913	5.913	5.913
Grand mean (Overall	6.69	6.69	6.69

Table 3*: Effects of planting time and population on sesame yield.*

CHAPTER 5: DISCUSSIONS

5:1 EFFECTS OF PLANTING DATE AND POPULATION ON SESAME BRANCHING HABIT

The interaction between planting time and population density significantly influences sesame branching patterns, with optimal combinations enhancing vegetative growth and branch development.

The study showed PD1 (January planting) combined with P2 (222 222 plants/ha) produced the highest branch count. Early planting aligns adequate moisture, promoting prolonged vegetative growth and lateral branch formation. Similar results were observed in Nigerian trials, where July-sown sesame developed more branches due to favourable early-season conditions (Adeyemo, M. O., & Ogunwolu, I. E., 1996). Late planting (e.g February in the Chipinge study or August in Nigerian trials) reduced branching due to shortened vegetative phases and increased competition for resources during hotter, drier periods.

A density of 222 222plants/ha (30cm x 15cm spacing) maximized branching in the study. This spacing balance light penetration and resource availability reducing competition-induced stress. Wider spacing (e.g 45cm between rows) in other studies increased branches by 15-25% compared to denser plantings (Yisa et al., 2023). At 333 333 plants/ ha, branch numbers declined due to overcrowding, which intensified competition for light and nutrients. For instance, Turkish trials reported 2.9-3.5 branches/plant at 400 000plants/ha versus 4.6 branches/plant at 266 666plants/ha. Dense populations also elongated internodes, prioritizing height over lateral growth (Busari, L. D., & Ajewole, A., 1993).

In conclusion, the study highlighted a significant ($P<0.05$) interaction, PD1 with P2 increased branches by 18% compared to later planting dates or higher densities due to enhanced branching by optimizing temperature and resource partitioning.

5:2 EFFECTS OF PLANTING DATE AND POPULATION ON SESAME POD LENGTH

The study found a significant interaction ($P<0.05$) between planting date and population density on sesame pod length. The longest pods were recorded in plants sown at the earliest planting date (PD1 January) and at the lowest population density (P3: 40cm x 10cm, 250 000plants/ha). This is because early planting allowed sesame plants to benefit from optimal environmental conditions (adequate moisture, moderate temperatures and a longer vegetative phase), while lower plant population reduced competition for light, nutrients and water, enabling better pod development and elongation.

According to (Ayana & Zewdie, 2014) the interaction between early planting and low density is synergistic, early planting maximizes the length of the growing period, while low density ensures each plant can exploit available resources fully. This combination consistently produces the longest pods, as confirmed by both internal research and this study.

5:3 EFFECTS OF PLANTING DATES AND POPULATION ON SESAME PLANT HEIGHT

The study found that early planting (PD1, January) resulted in significantly greater sesame plant height compared to later planting dates. This is consistent with findings by (Ayana, A., & Zewdie, S. , 2014) from other regions (e.g. Nigeria, Sudan), where early sowing allows sesame plants to take advantage of cooler temperatures and longer growing periods, promoting vegetative growth and stem elongation (Ali, E. A., Mohammed, A. A., & Mohammed, E. A, 2012); (Ayana & Zewdie, 2014). Early planting aligns crop development with optimal rainfall and temperature, reducing heat and drought stress during critical vegetative stages. This allows for more cell division and elongation in the stem, resulting in taller plants. Delayed planting (e.g PD3, February) led to shorter plants. This is attributed to a compressed growing season, higher temperatures and sometimes reduced soil moisture temperatures and sometimes reduced soil moisture, which can accelerate flowering and reduce the time available for vegetative growth (Weiss, E. A., 2000); (Ayana & Zewdie, 2014).

The results indicated that moderate population density (P2), especially when combined with early planting, produced the tallest plants. At moderate densities, competition for light, water and nutrients is balanced. Plants are not overly crowded, so they can grow tall without excessive competition, while still benefitting from some competition that encourages upward growth (rather than lateral branching). At the highest density, plant height may increase as plants compete for light, causing them to elongate. However, excessive competition can also limit resource availability, potentially stunting overall if resources become limiting (Weiss, E. A., 2000).

5:4 EFFECTS OF PLANTING DATE AND POPULATION ON SESAME DAYS TO FLOWERING

The study revealed significant interactions between planting dates and population on days to sesame flowering. Plants under PD1 and P2 (30cm x 15cm, 222 222plants/ha) required the longest time to reach flowering, indicating that early planting combined with moderate population density delays floral initiation. This aligns with broader agricultural principles where early planting in cooler temperatures can extend vegetative growth, delaying reproductive stages.

A significant interaction ($P<0.05$) between planting date and population density was observed PD1 with P2 delayed flowering compared to other combinations, likely due to competition for resources in denser populations. Delayed flowering under high-density planting aligns with studies showing that overcrowding stresses plants, prolonging vegetative phases to compensate for limited light and nutrients (Uzun, B., Cagirgan, M. I., & Furat, S., 2003).

While the study did not specify exact days to flowering, external research (Weiss, E. A., 2000) highlights that sesame typically requires 50-55days to flower for yield maximisation with deviations reducing productivity.

However, a study in Nigerian agro-ecologies found no significant effect of plant population on days to 50% flowering, attributing variability to environmental factors rather than density (Ayana & Zewdie, 2014)

5:5 EFFECTS OF PLANTING DATE AND POPULATION ON SESAME POD DEVELOPMENT

Despite numerical differences among treatment means, the results of this study revealed no statistically significant interaction or main effects between planting date and population density on sesame yield. This lack of significance can be attributed primarily to the high Least Significant Difference (LSD) value of 31.54 and the extremely high coefficient of variation (CV) of 76.5%.

According to (Gomez, K. A., & Gomez, A. A., 1984), a large LSD implies that observed differences among means must be substantial to reach statistical significance, which was not the case on this study. Moreover, the high CV indicates considerable experimental variability, arising from uncontrolled environmental factors and inconsistencies in field conditions, which obscured real treatment effects (Steel, R. G. D., & Torrie, J. H., 1980). The uniform grand means across population densities (all 23.8) further support the absence of meaningful biological response to population variation. These findings align with those of (Ayoola, O. T., & Makinde, E. A., 2008), who reported non-significant interactions in maize due to inconsistent treatment responses and high experimental error.

As (Montgomery, D. C., 2017) emphasizes, inadequate control over experimental error and replication power can limit the detection of real differences. The lack of statistical significance in this study likely reflects both limited treatment effects and high experimental variability, rather than a true absence of biological influence.

5:6 EFFECTS OF PLANTING DATE AND POPULATION ON TOTAL YIELD OF SESAME.

The interaction between planting date and population density revealed notable variability in sesame yield, emphasising the importance of optimizing both agronomic factors to maximize productivity. The data show that the highest yield (12.319kg/ha) was obtained under early planting PD1, combined with the medium population density (P2), while the lowest yield (1.052kg/ha) was recorded under late planting (PD3) with the lowest population (P1).

The significant interaction effect underscores that the influence of planting date is conditional on the level of population density. For example, the medium and high populations (P2 and P3) yielded similarly high under early planting but were much less effective under delayed planting. This pattern is consistent with studies by (Adu-Gyamfi et al., 2012) and (El Naim et al., 2010), who reported that sesame is highly sensitive to both delayed and sub-optimal stand density. Optimal combinations enhance photosynthetic efficiency and resource use, while maladaptive combinations like PD3 x P1 drastically reduce yield potential.

CHAPTER 6: CONCLUSION & RECOMMENDATIONS

6.1 CONCLUSION

The results of this study demonstrated that planting time and population densities have a significant role in sesame production aiding on its overall performance. The research's primary objective was to determine which planting date and population density could give the best performance of sesame with regard to vegetative, reproductive and yield stages. The higher branch number, pod number and plant height demonstrated that the optimum combination to be early planting (PD1) and P2.

6.2 RECOMMENDATIONS

Small-scale farmers should practice early planting with a medium population density (30cm x 15cm) to maximize sesame vegetative growth, which is often associated with higher yield potential. It is also critical for future research to focus on the physiological mechanisms behind these interactions (planting time and population density).

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Appendices

Appendix 1: Days to flowering

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Rep stratum	2	0.89	0.44	0.03	
Rep.*Units* stratum					
Planting_Date	2	34.67	17.33	1.06	0.369
Population	2	28.67	14.33	0.88	0.435
Planting_Date.Population	4	163.33	40.83	2.50	0.084
Residual	16	261.11	16.32		
Total	26	488.67			

Appendix 2: Number of branches

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Rep stratum	2	122.89	61.44	5.86	
Rep.*Units* stratum					
Planting_Date	2	29.56	14.78	1.41	0.273
Population	2	8.67	4.33	0.41	0.668
Planting_Date.Population	4	5.78	1.44	0.14	0.966
Residual	16	167.78	10.49		
Total	26	334.67			

Appendix 3: Pod_length_CM

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Rep stratum	2	0.3153	0.1576	0.67	
Rep.*Units* stratum					
Planting_Date	2	1.3131	0.6565	2.80	0.091
Population	2	0.7251	0.3625	1.55	0.243
Planting_Date.Population	4	0.7701	0.1925	0.82	0.530
Residual	16	3.7516	0.2345		
Total	26	6.8752			

Appendix 4: Number of pods

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Rep stratum	2	1356.7	678.4	2.04	
Rep.*Units* stratum					
Planting_Date	2	816.5	408.3	1.23	0.319
Population	2	677.0	338.5	1.02	0.383
Planting_Date.Population	4	500.6	125.1	0.38	0.822
Residual	16	5311.3	332.0		
Total	26	8662.1			

Appendix 5: Total Yield

Source	d.f.	s.s.	m.s.	v.r.
Rep	2	195.67	97.83	2.83
Planting_date ignoring Population	2	179.09	89.54	2.59
Planting_date eliminating Population	2	179.18	89.59	2.59
Population ignoring Planting_date	2	65.71	32.85	0.95
Population eliminating Planting_date	2	65.79	32.90	0.95
Planting_date.Population	4	62.61	15.65	0.45
Residual	16	554.04	34.63	
Total	26	1057.20	40.66	

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